

## Mad Cow Disease

### An Opportunity for Preventive Medicine?

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Cost considerations are being increasingly employed as a basis for health care decisions. Formal cost-effectiveness analysis explicitly attempts to compare different treatment or prevention strategies based on both cost and effectiveness differences. By this manner, cost-effectiveness analysis provides decision makers with valuable data for making important and difficult decisions about interventions.<sup>1</sup> "Back of the envelope" strategies can also aid in decision making by providing general information about the relative differences of various interventions.<sup>2</sup>

The recent occurrence of a serious but rare neurologic disease in Great Britain offered another potential role for cost analysis. In this instance, a relatively simple analysis leads to information with major implications for public policy. The disorder in question is the "mad cow disease," or bovine spongiform encephalopathy (BSE). Widespread anxiety was generated when officials made public a possible association between BSE and human variant Creutzfeldt-Jakob disease (CJD; vCJD).<sup>3</sup> Both dementing disorders may be caused by prions.<sup>4</sup> Because of the common features of the two conditions, it is speculated that vCJD may have been contracted by ingesting beef from cattle with BSE.<sup>5</sup> Indeed, ten human cases of vCJD were reported as of April 1996.<sup>3</sup> Though a rare disease, its serious nature and possible linkage to dietary habits of the entire English population rendered necessary a governmental policy to address public health and fears.<sup>5,6</sup>

Options considered by the British government and health officials included the following:

- Immediately killing all British cattle, both young and old;
- Destroying the carcasses of older dairy cows as they come up for slaughter (rather than selling this beef as low-grade meat); and
- Continuing the current system of processing older dairy cows as low-grade meat.

Given that BSE is a disease of cattle older than 30 months and that the incidence of BSE in cows born after 1993 is low (because of dietary precautions instituted on farms in the late 1980s),<sup>7,8</sup> we postulated that killing younger cows in addition to older cows would do little to prevent the spread of vCJD. Older cows (born before 1993) may, however, present a risk to humans.

We performed a back-of-the-envelope analysis<sup>2</sup> comparing three strategies. In the first, the entire British herd is immediately slaughtered and BSE is eradicated. As a ten-year incubation between exposure to BSE and the development of vCJD is postulated, six new cases of vCJD would still be expected to develop yearly for another decade. In the second scenario, the carcasses of older cows are destroyed. Because this strategy prevents people from eating older cows, we assumed it would be effective (95% for the purposes of this analysis) in halting the spread of BSE. The incidence of vCJD would therefore decrease by 95% after the ten-year latency period. Finally, some think that all cattle will be disease-free in six years (again, because of dietary changes instituted on farms in the late 1980s). Therefore, even if the British government continues to allow the human consumption of older cattle, vCJD will remain a public health problem for only another 16 years. The human consequences of these strategies are presented in Table 1.

By this analysis, destroying older dairy cows rather than consuming them would prevent about 57 cases of vCJD over six years. Because reported cases of vCJD occurred in adults with an average age of 26 years, about 50 years of life expectancy would be lost with each premature death due to vCJD. Therefore, a total human cost of 57 lives times 50 years per life, or 2,850 years of life, might be lost to vCJD if nothing were done. The possible cost of destroying the older cows has been estimated at \$1 billion.<sup>9</sup> Therefore, the cost-effectiveness ratio (\$1 billion ÷ 2,850 years) of destroying older cows is about \$350,000 per year of life saved.

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**ABBREVIATIONS USED IN TEXT**

BSE = bovine spongiform encephalopathy

CJD = Creutzfeldt-Jakob disease

vCJD = variant CJD

Our incidence assumption is based on ten cases reported by the CJD surveillance unit divided by the at-risk British population. What if the CJD surveillance unit only identified the tip of the iceberg? If vCJD is more prevalent, its effect will be greater. Because tissue is required for a definitive diagnosis and because the disease is uncommon with unusual manifestations, it is possible that many cases were missed. Alternatively, the incidence of vCJD might rise in the future, just as the incidence of BSE increased in the early 1980s. If the actual incidence of vCJD is three times higher than currently reported, then the data in Table 2 apply.

In this case, destroying older cows might save 8,550 years of life ( $171 \text{ lives} \times 50 \text{ years per life}$ ). The cost-effectiveness ratio would then fall to about \$120,000 per year of life saved. In general, public health programs are considered attractive if their cost-effectiveness ratio is less than \$40,000.<sup>10</sup> Many widely practiced therapies (the use of nonionic radiographic contrast material, drug therapy for hypercholesterolemia, or warfarin sodium instead of aspirin for nonvalvular atrial fibrillation when other risk factors for stroke are absent)<sup>11-13</sup>, however, have cost-effectiveness ratios closer to \$150,000 per year of life saved. Whether society can afford to fund such programs is often debated. In any case, our simple analysis suggests that destroying older cows may be at least as cost-effective as some common medical interventions.

Should the entire herd be slaughtered and the problem potentially solved? In fact, some advocate slaughtering all British cattle. This additional effort would probably save only a few additional lives. Even when vCJD is assumed to be more prevalent (as in Table 2), killing all the cows only saves an additional 450 years of life ( $9 \text{ additional lives} \times 50 \text{ years per life}$ ). Furthermore, this annihilation would be expensive, perhaps \$1 billion more than simply destroying the older cows. Therefore, the cost per additional year of life saved for this aggressive strategy is about \$4.5 million ( $\$2 \text{ billion} \div 450 \text{ years of life}$ ) based on our assumptions. Most would agree that this strategy is unusually expensive. Even if the numbers used in our analysis are somewhat off, the conclusion will likely be similar: targeting the high-risk reservoir (older cows) is expensive because vCJD is rare and the reservoir is large. Nevertheless, many public health interventions are similarly expensive. On the other hand, a policy designed to eradicate the problem by targeting all possible reservoirs would cost far more than currently recommended public health programs because the marginal benefit of this tremendous effort would be small.

Money is not the only issue. Many think that the heart and soul of Britain are symbolized by beef. Beginning

TABLE 1.—Number of Human Cases of Variant Creutzfeldt-Jakob Disease (vCJD) Based on Each of 3 Strategies

Strategy	Cases of vCJD in Next 10 yr, No.	Cases of vCJD in Years 11–16, No.
Kill all cows . . . . .	100	0
Destroy older cows . . . . .	100	3
Eat the beef . . . . .	100	60

with the American Revolution, through the loss of India, and with the current debate over the future of its monarchy, British pride and sense of self-worth are in a precarious state. If not for the stability of British beef over the years, symbolic of the heartiness and resiliency of the land itself, the British people would have strongly considered emigrating en masse to France long ago. Thus, it is no trivial matter that trust in British beef be restored as soon as possible.

Our simplified cost-effectiveness analysis has several limitations. Neither the precise incidence of vCJD nor the efficacy of destroying older cows to prevent the disease is known. Furthermore, although our cost data are based on published estimates, they are not precise. Nevertheless, the British government has to act quickly, even though a complete understanding of the relationship between BSE and vCJD may be decades away. One of the strengths of cost-effectiveness analysis is to highlight which strategies are possibly reasonable when incomplete data preclude a definitive answer.

If the United States is faced with a decision similar to that faced by the British, notwithstanding current evidence that no American cases of vCJD have occurred,<sup>14,15</sup> policy makers in this country may also have to act on less than optimal data. Fortunately, we have not seen a BSE epidemic, perhaps for the following reasons: First, the strains of the related sheep disease (called scrapie) in the United States differ sufficiently from those seen in Great Britain and, thus, may not breach the species barrier to cattle.<sup>16</sup> Second, the level of infectivity in the United States may be sufficiently low as to prevent transmitting disease from sheep to cattle.<sup>16</sup> Furthermore, several precautionary steps have already been taken in the United States, including embargoing the importation of cattle from Great Britain, restricting

TABLE 2.—Number of Human Cases of Variant Creutzfeldt-Jakob Disease (vCJD) Based on Each Strategy if the Actual Incidence of vCJD Were Increased 3-fold

Strategy	Cases of vCJD in Next 10 yr, No.	Cases of vCJD in Years 11–16, No.
Kill all cows . . . . .	300	0
Destroy older cows . . . . .	300	9
Eat the beef . . . . .	300	180

the movement of scrapie-infected sheep into uninfected flocks, and providing incentives to the sheep farming industry to reduce the incidence of scrapie in the United States.<sup>16</sup>

Fear is a powerful emotion. Some British government officials have implied that the public's fear is without scientific basis and that the response to mad cow disease has been hysterical.<sup>17</sup> But a lack of proof of a direct association does not prove there is no association.<sup>18</sup> As long as the British public believes that the new cases of vCJD may be associated with BSE, then it is not unreasonable for the British government to act on this belief and to pursue a strategy of destroying older cows.

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